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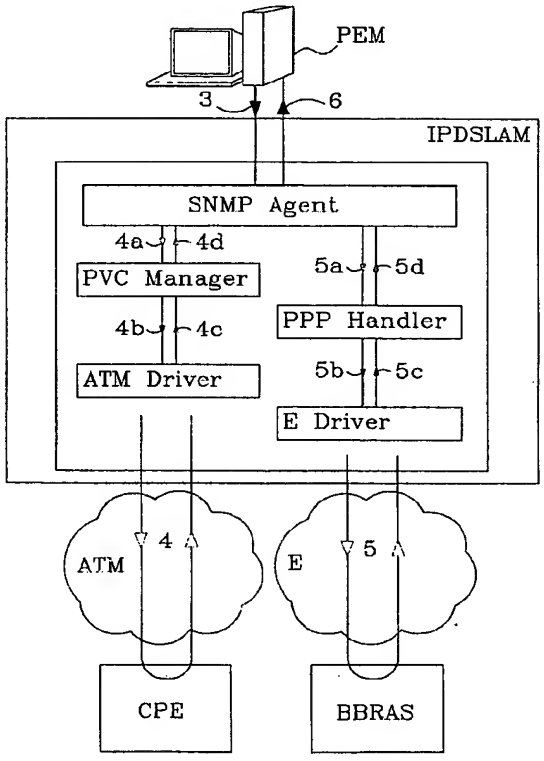
(54) Title: METHOD AND ARRANGEMENT TO PERFORM A LINK TEST BETWEEN END NODES IN DSL COMMUNICATION NETWORKS, USING SEVERAL SEPARATE LOOP-BACK TESTS




(57) Abstract: The present invention relates to a method in a communications network to perform a link test between end 5 nodes CPE, BBRAS. The end nodes are communicating mutually via an intermediate node IPDSLAM. A first node CPE is connected to the intermediate node IPDSLAM via a first transmission media ATM and a second node BBRAS is connected to the intermediate node IPDSLAM via a second transmission media ETHERNET. The method comprises the following steps: Executing a first loop-back test between the intermediate node IPDSLAM and the first node CPE according to a standard of the first transmission media ATM. Executing a second loop-back test between the intermediate node IPDSLAM and the second node BBRAS according to a standard of the second transmission media ETHERNET.

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# METHOD AND ARRANGEMENT TO PERFORM A LINK TEST BETWEEN END NODES IN DSL COMMUNICATION NETWORKS, USING SEVERAL SEPARATE LOOP-BACK TESTS

The present invention relates to methods and arrangements to perform link tests between nodes in a communications network, which nodes are communicating mutually via more than one transmission media.

## DESCRIPTION OF RELATED ART

Traditionally, Digital Subscriber Line DSL networks are based on Asynchronous Transfer Mode ATM. ATM is a high-speed cell based data transmission protocol. A Digital Subscriber Line Access Multiplexer DSLAM is a device that takes a number of DSL subscriber lines and concentrates them to a single ATM line. Today's DSLAM network infrastructure is based on ATM technology from Customers Premises Equipment CPE into a Broadband Remote Access Server BBRAS.

The ATM layer loop-back capability allows for operations related information to be inserted at one location along a Virtual Path Connection VPC and returned or looped-back at a different location. When a customer complains, operators normally execute a loop-back command in the BBRAS for testing the ATM Virtual Circuit towards the CPE. The CPE answers back with a loop-back signal. The bases for this function are described in ITU-T I.610. This test verifies the physical link between the CPE and the BBRAS.

DSLAM products have recently been launched based on Ethernet DSL technology. Nodes may instead of communicating mutually via only one transmission media, mutually communicate via more than one transmission media. A problem arises when facing the operator's need of having the same testing functionality in for example Ethernet based DSL network as they have in their existing DSL network based on only ATM.

By adding Ethernet into the broadband network the standard and used method becomes limited to only be between for example the DSLAM and the CPE, i.e. where the ATM technology exists. A full verification between the CPE and the broadband network, which is based on for example both ATM technology and switched Ethernet, cannot be executed in the operators network according to the standard practice.

**SUMMARY OF THE INVENTION**

The present invention solves problems related to testing of a link between end nodes when multiple transmission media's are used for mutual communication between the nodes.

A purpose with the invention is to test the link between the end nodes according to operator's standard practice also when more than one transmission media is used for the communication between the nodes.

The problem is solved by the invention by testing, from an intermediate node located between the end nodes, each link part between the intermediate node and the end nodes, separately.

More in detail, the problem is solved by the invention by a method comprising execution of a first loop-back test from the intermediate node to a first end node according to a first transmission media standard, and execution of a second loop-back test from the intermediate node to a second end node according to a second transmission media standard.

In another aspect, the problem is solved by the invention by an arrangement comprising an intermediate node located between two end nodes. The intermediate node comprises means to receive a request of link test. The intermediate node

further comprises means to initiate loop-back test towards each end node separately.

An advantage with the invention is that a link between end nodes can be verified according to an operator's normal practice even though different transmission media standards are used for the communication between the nodes.

Another advantage is that configuration of some higher-level protocols like PPP over Ethernet PPPoE can be tested too. This is done by the intermediate node, which acts on behalf of the Customer Premises Equipment (CPE).

Another advantage is that the test can be done per service each customer request from different service providers.

Yet another advantage is that the operators customer care centre, with this function combined with other standard functions with the DSL standard, e.g. dying gasp, will have a complete customer overview. This in case of complaints to the customer care centre, where the most complaints is related to customer premises equipment (computer and it's set-up) and not the network in general.

The invention will now be described more in detail with the aid of preferred embodiments in connection with the enclosed drawings.

## BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows a block schematic illustration of a communication network comprising two end nodes and an intermediate node. The end nodes communicate mutually via more than one transmission media.

Figure 2 shows a block schematic illustration of the intermediate node. The intermediate node is connected to the end nodes via different transmission media.

Figure 3 shows a flow chart illustrating some of the most significant steps in a test method according to the invention.

**DETAILED DESCRIPTION OF EMBODIMENTS**

In figure 1 is disclosed a communication network CN. The network comprises two end nodes CPE and BBRAS. The first end node is Customer Premises Equipment CPE for receiving and transmitting voice and/or data signals. The second end node is a Broadband Remote Access Server BBRAS. The two end nodes CPE and BBRAS are communicating mutually via a Digital Subscriber Line Access Multiplexer DSLAM. Á DSLAM that works as a bridge between ATM and Ethernet based networks is called Internet Protocol Digital Subscriber Line Access Multiplexer IPDSLAM. In this embodiment, the transmission media between the CPE and the IPDSLAM is provided by Asynchronous Transfer Mode ATM, and the transmission media between the IPDSLAM and the BBRAS is provided by Ethernet. The IPDSLAM serves as a router between one or more customer equipment and one or more access server equipment. The Customer Premises Equipment CPE is connected to a Customer Care Center CCC. In this example, the CCC is connected to a Public Ethernet Manager PEM that is connected to the IPDSLAM but as an alternative the CCC can be directly interfaced to IPDSLAM. The Public Ethernet Manager PEM initiates loop tests according to the invention, after for example a customer complaint. This will be further explained below.

Figure 2 discloses software implementations in the IPDSLAM, which are involved during a test session according to the invention. The software implementations have been disclosed in the figure with arrow-symbols and block-symbols within the IPDSLAM. Figure 2 shows a test arrangement located within the IPDSLAM. The IPDSLAM is attached to the Public Ethernet Manager PEM, the Customer Premises Equipment CPE and the Broadband Remote Access Server BBRAS - compare with figure 1. Cloud symbols represent the different transmission media's, i.e. ATM and Ethernet. A Simple Network Management Protocol SNMP Agent is located inside the

IPDSLAM and constitutes an interface to the Public Ethernet Manager PEM located outside the IPDSLAM. The SNMP Agent is communicating, via a Permanent Virtual Circuit Manager, a PVC manager, to an ATM driver that is an interface to the ATM transmission media ATM. The PVC manager has knowledge of permanent virtual circuits in the ATM transmission media. B-ISDN operation and maintenance principles and functions can be found in ITU-T Recommendation I.610.

The SNMP agent is furthermore attached via a Point-to-Point Handler i.e. a PPP Handler, to an Ethernet driver that is an interface to the Ethernet transmission media E. The PPP Handler is able to locate servers in the Ethernet transmission media. A method for transmitting PPP over Ethernet can be found in Network Working Group RFC 2516.

A method according to a first embodiment of the invention will know be described. References that will be used in the description below can be found in figures 1 and 2. The method shows a link test according to the invention after a customer complaint. The link is situated between two end nodes CPE and BBRAS. The nodes are communicating mutually via more than one transmission media, in this example Asynchronous Transfer Mode ATM and Ethernet E. The link comprises two link parts, one part between the IPDSLAM and the CPE and one part between the IPDSLAM and the BBRAS. The method comprises the following steps:

- The Customer detects a potential link error between the CPE and the Broadband Remote Access Server BBRAS.
- The customer sends a complaint message 1 to the Customer Care Center CCC.
- The CCC examines the complaint message 1 and finds a local server, i.e. the Public Ethernet Manager PEM that is associated to the link concerned by the complaint.

- The CCC sends a request link test message 2 from the CCC to the PEM.

- The PEM initiates a link test by sending an initiate link test message 3 from the PEM to the Simple Network Management Protocol SNMP Agent in the Digital Subscriber Line Access Multiplexer IPDSLAM.

The test is divided into two parts, at first the test of the ATM transmission media part and then the test of the Ethernet transmission media part. It is to be noted that the signaling within the IPDSLAM, which now will be explained, just is an example and can be modified within the scope of the claims. The internal IPDSLAM signaling is disclosed in figure 2.

- The SNMP Agent request from PEM, an ATM circuit check message 4a to be sent to the Permanent Virtual Circuit PVC Manager. The PVC Manager has knowledge of permanent virtual circuits in the ATM transmission media.

- The PVC Manager forwards information about the virtual circuit in question in a circuit check message 4b to the ATM Driver.

- The ATM driver transmits an F5/OAM loop-back test signal 4 to the CPE.

- The CPE returns the test signal 4 to the ATM Driver. The loop-back test signal 4 detects errors like incorrect configuration of ATM PVC (identified by VPI/VCI) in the CPE equipment (when manually configured).

- The result of the loop-back test signal 4 is forwarded from the ATM Driver to the SNMP Agent. The result is sent in ATM link result messages 4c and 4d via the PVC Manager.

- The SNMP Agent now continues by testing the Ethernet part i.e. if the Access Method allows a test on this part of the network, like in this PPPoE case.

- The SNMP Agent sends an Ethernet check message 5a to the Point-to-Point PPP Handler. The Purpose of the PPP Handler is to monitor bridged PPPoE traffic in the IPDSLAM and intercept replies on discovery messages that was sent by this test function.

- The PPP Handler sends a discovery message 5b to the Ethernet E Driver.

- The E driver executes a PPP over Ethernet PPPoE loop-back test signal 5 to the BBRAS.

- The BBRAS returns the test signal 5 to the E Driver. The loop-back test signal 5 detects errors like incorrect configuration of the switched Ethernet network (including any Virtual LAN configuration), malfunction in the network, and incorrect configuration or malfunction of PPP servers in BBRAS.

- The result of the loop-back test signal 5 is forwarded from the E Driver to the SNMP Agent. The result is sent in E link result messages 5c and 5d via the PPP Handler.

After finished tests, the SNMP Agent reports the result to the Customer Care Center CCC via PEM.

- The result of the two tests ATM link test and Ethernet link test is forwarded from the SNMP Agent to the PEM in a message 6.

- The result of the two tests ATM link test and Ethernet link test is forwarded from the PEM to the CCC in a message 7.

If the ATM test fails it should be verified that the ATM PVC in the CPE is configured correct. Otherwise more detailed investigation is needed.

If the PPPoE test fails then the problem is either in the switched Ethernet network or in the BBRAS. In both cases more detailed investigation is needed (not involving the CPE equipment).

The actions can lead to whether service personal must go in the field and correct broken cables or change configuration of systems in the network. Sometimes changes of configuration of network elements leads to other failures and broken services.

It is to be observed that the message flow described in the above example, just is an example. Different variations are possible within the scope of the invention. For example can the PVC Manager report back to the PEM, the number of virtual circuits, before the actual ATM test starts, which test is initiated by the PEM. Other Ethernet based protocols like discovery of DHCP servers could replace the PPP discovery. In another example the SNMP Agent reports test results to PEM after each test, first the ATM test result and then the Ethernet test result.

In figure 3 some of the most significant steps of the described first embodiment is disclosed in a flow chart. The flow chart is to be read together with the earlier shown figures. The steps are as follows:

- The Customer Premises Equipment CPE detects link failure i.e. a potential link error between the CPE and the Broadband Remote Access Server BBRAS. The Public Ethernet Manager PEM that is connected to the link concerned by the complaint is informed of the complaint. This is shown in figure 3 with a block 101.

- The PEM initiates a link test by sending an initiate link test message 3 from the PEM to the Simple Network Management Protocol SNMP Agent in the Digital Subscriber Line Access Multiplexer IPDSLAM. This is shown in figure 3 with a block 102.

- The ATM driver executes a F5/OAM loop-back test signal 4 to the CPE. This is shown in figure 3 with a block 103.

- The CPE returns the test signal 4 to the ATM Driver. This is shown in figure 3 with a block 104.

- The E driver executes a PPP over Ethernet PPPoE loopback test message 5 to the BBRAS. This is shown in figure 3 with a block 105.

- The BBRAS returns the test signal 5 to the E Driver. This is shown in figure 3 with a block 106.

- The result of the two tests, ATM link test and Ethernet link test, is forwarded from the IPDSLAM to the PEM in a message 6. This is shown in figure 3 with a block 107.

The invention is of course not limited to the above described and in the drawings shown embodiments but can be modified within the scope of the enclosed claims. Different variations are possible within the scope of the invention. The intermediate node between the two end nodes has been referred to as being a router. The intermediate node can instead have other functionalities. The transmission media's referred to in the example above are ATM and Ethernet. Other types of media can occur. The second loop-back test is executed by initiating point-to-point over Ethernet but can for examples instead comprise variations like DHCP test. By having Ethernet as new transport media between DSLAM and BBRAS, the Ethernet philosophy opens doors for other types

of Broadband Remote Access Servers, e.g. DHCP servers which offers other type of validation methods for access to the service / broadband network. The transport media is the same but the access method used differs from the one described. The end nodes are in the example Customer Premises Equipment CPE and a Broadband Remote Access Server BBRAS. The end nodes can of course be of another type.

## CLAIMS

1. Method in a communications network to perform a link test between end nodes (CPE, BBRAS) which are communicating mutually via an intermediate node (IPDSLAM), a first end node (CPE) being connected to the intermediate node (IPDSLAM) via a first transmission media (ATM) and a second end node (BBRAS) being connected to the intermediate node (IPDSLAM) via a second transmission media (E), the method being ***characterised by*** the following steps:

- executing a first loop-back test between the intermediate node (IPDSLAM) and the first node (CPE) according to a standard of the first transmission media (ATM);

- executing a second loop-back test between the intermediate node (IPDSLAM) and the second node (BBRAS) according to a standard of the second transmission media (E).

2. Method to perform a link test according to claim 1 whereby the first loop-back test is executed in the intermediate node (IPDSLAM) by initiating OAM flow on a virtual channel according to the ATM-standard.

3. Method to perform a link test according to claim 1 or 2 whereby the second loop-back test is executed in the intermediate node (IPDSLAM) by initiating point-to-point protocol over ethernet.

4. Arrangement in a communications network to perform a link test between end nodes (CPE, BBRAS) which are communicating mutually via an intermediate node (IPDSLAM), which arrangement comprises the intermediate node (IPDSLAM), the intermediate node being connected to a first end node (CPE) via a first transmission media (ATM) and which intermediate node is connected to a

second end node (BBRAS) via a second transmission media (E), the arrangement being ***characterised by***:

- means in the intermediate node (IPDSLAM) to execute a first loop-back test between the intermediate node (IPDSLAM) and the first node (CPE) according to a standard of the first transmission media (ATM);

- means in the intermediate node (IPDSLAM) to execute a second loop-back test between the intermediate node (IPDSLAM) and the second node (BBRAS) according to a standard of the second transmission media (E).

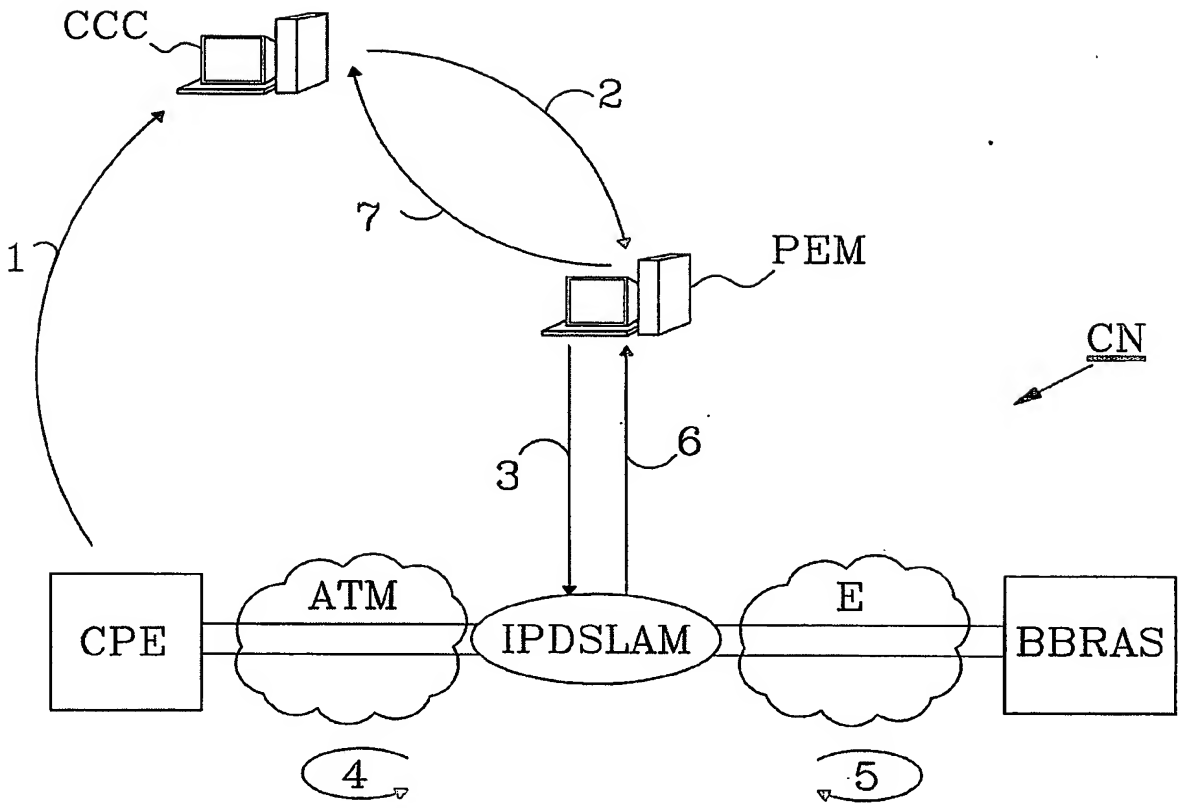


Fig. 1

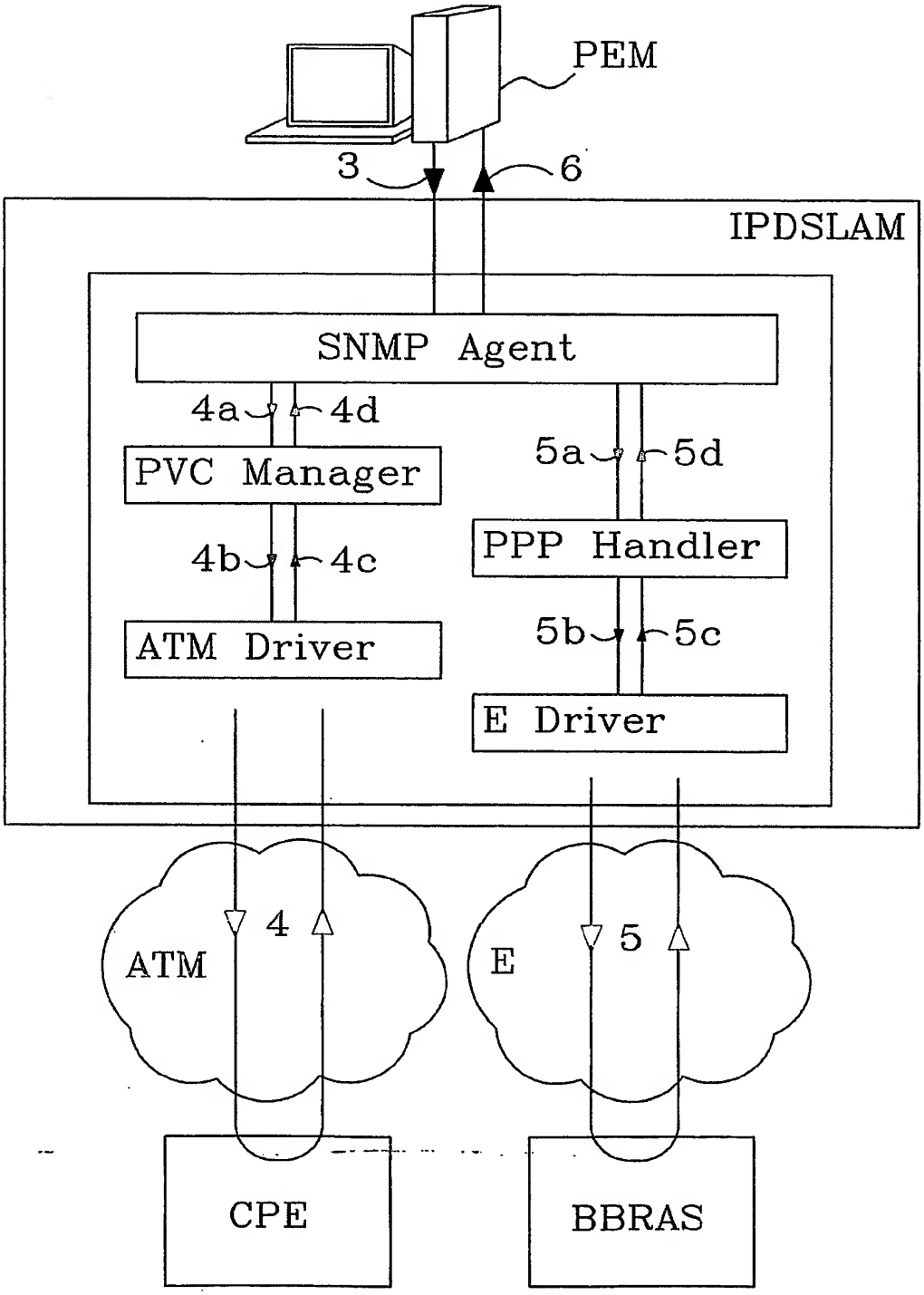
PEM
3
6
IPDSLAM
SNMP Agent
4a
4d
PVC Manager
5a
5d
PPP Handler
4b
4c
ATM Driver
5b
5c
E Driver
ATM
4
E
5
CPE
BBRAS

Fig. 2

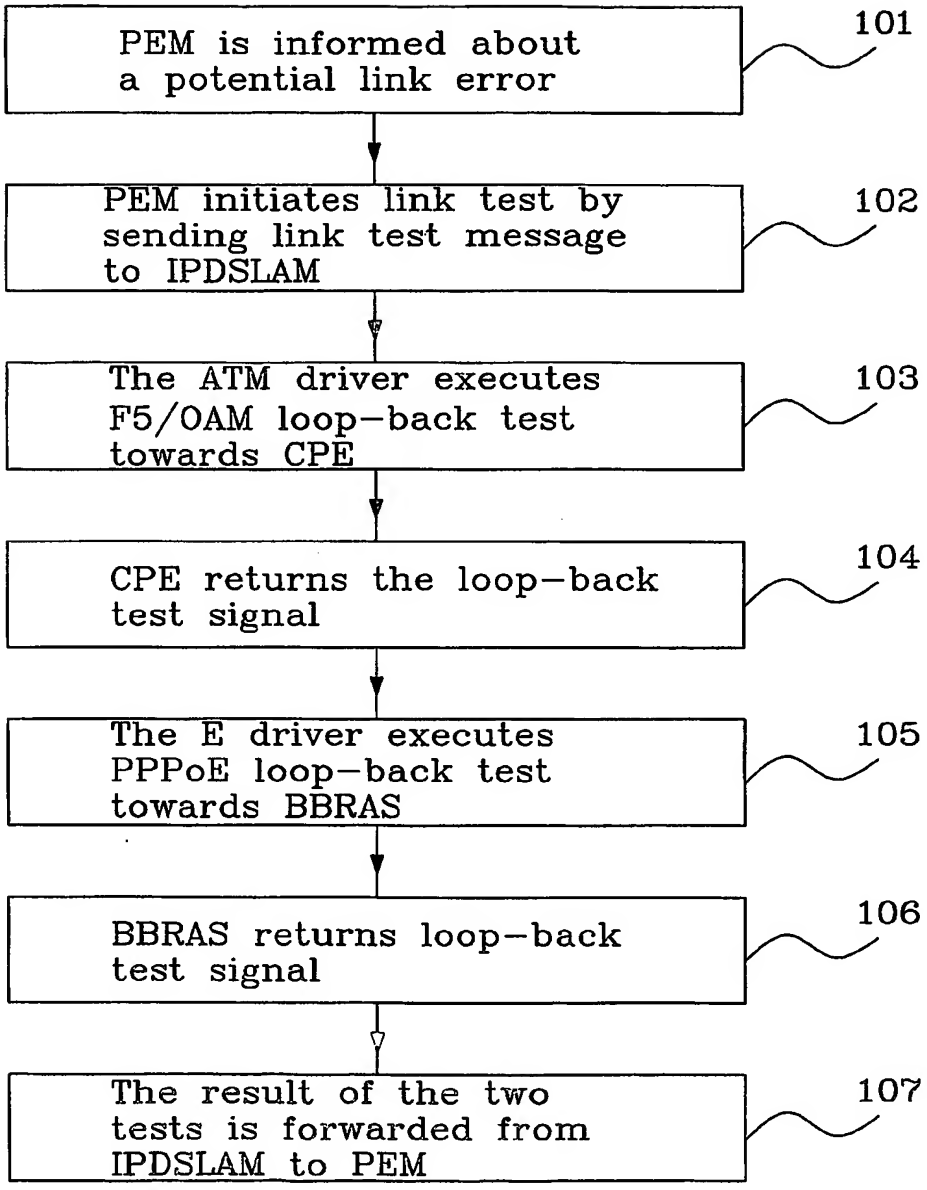
PEM is informed about a potential link error
101
PEM initiates link test by sending link test message to IPDSLAM
102
The ATM driver executes F5/OAM loop-back test towards CPE
103
CPE returns the loop-back test signal
104
The E driver executes PPPoE loop-back test towards BBRAS
105
BBRAS returns loop-back test signal
106
The result of the two tests is forwarded from IPDSLAM to PEM
107

Fig. 3

# INTERNATIONAL SEARCH REPORT

International application No.
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A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H04M 1/24, H04L 12/26, H04Q 11/04
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H04M, H04L, H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ, INSPEC, COMPENDEX, TDB

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
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| A | GALLI, S. et al.: Loop makeup identification via single ended testing beyond mere loop qualification. In: Selected Areas in Communication, IEEE Journal, Jun 2002, pages 923-935, vol.20, issue 5. -- | 1-14 |
| A | DAOU, F.H.: Overview of ADSL test requirement towards conformance, performance and interoperability. In: AUTOTESTCON '98. IEEE Systems Readiness Technology Conference., 1998 IEEE. Publ. on 24-27 Aug 1998, Salt Lake City, USA, pages 413-420 -- | 1-14 |

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
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"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
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# INTERNATIONAL SEARCH REPORT

Information on patent family members

06/09/03

International application No.
PCT/SE 03/00349

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
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